

AMENDMENTS TO THE CLAIMS

Kindly cancel claims 4, 7, 12 and 14 and amend claims 1, 2, 5, 8-11, 13 and 36 as shown in the listing of claims below. This listing of claims will replace all prior versions, and listings of claims in the application.

5

LISTING OF CLAIMS

1 Claim 1. (currently amended) A multi-layer vertical comb-drive actuator comprising:
2 a) a first comb structure having a plurality of first comb fingers; and
3 b) a second comb structure having a plurality of second comb fingers, wherein
4 the second comb structure is positioned such that the second comb fingers are
5 interdigitated and self aligned with the first comb fingers;
6 wherein ~~one or more of the first and second comb fingers includes~~ include at least one
7 first conductive layer and at least one second conductive layer, wherein the first and
8 second conductive layers are electrically isolated from each other, and
9 wherein the second comb fingers include a first and a second conductive layer, wherein
10 the first and second conductive layers of the second comb fingers are electrically
11 isolated from each other.

1 Claim 2. (currently amended) The multi-layer vertical comb-drive actuator of claim 1
2 wherein the first and second conductive layers of the first comb fingers are electrically
3 isolated by an insulating layer.

1 Claim 3. (original) The multi-layer vertical comb-drive actuator of claim 1 wherein the
2 first and second conductive layers are isolated by an air gap.

1 Claim 4. (cancel)

1 Claim 5. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[4]] 1, wherein one or more of the second comb fingers of the second comb structure has
3 at least one first conductive layer that is substantially aligned with the first conductive
4 layer of the first comb fingers of the first comb structure.

1 Claim 6. (original) The multi-layer vertical comb-drive actuator of claim 5, wherein an
2 application of a voltage between the second conductive layers of the first comb fingers

3 and the first conductive layers of second comb fingers causes relative movement between
4 the first and second comb structures.

1 Claim 7. (cancel).

1 Claim 8. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[7]] 1, wherein the first and second conductive layers of the second comb fingers are
3 electrically isolated by an insulating layer.

1 Claim 9. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[7]] 1, wherein the first and second conductive layers of the second comb fingers are
3 electrically isolated by an air gap.

1 Claim 10. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[7]] 1, wherein an application of a voltage between the first conductive layer of the first
3 comb fingers and the second conductive layer of the second comb fingers causes the
4 second comb structure to move relative to the first comb structure.

1 Claim 11. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[7]] 1, wherein an application of a voltage between the second conductive layer of the
3 first comb fingers and the first conductive layer of the second comb fingers causes the
4 second comb structure to move relative to the first comb structure.

1 Claim 12. (cancel)

1 Claim 13. (currently amended) The multi-layer vertical comb-drive actuator of claim
2 [[12]] 1, wherein the first comb structure and the second comb structure are fabricated
3 from a common substrate containing the first and second conducting layers.

1 Claim 14. (cancel)

1 Claim 15. (original) The multi-layer vertical comb-drive actuator of claim 1 further
2 comprising a means for measuring a capacitance between the first comb fingers and the
3 second comb fingers.

1 Claim 16. (original) The multi-layer vertical comb-drive actuator of claim 15 further
2 comprising a feedback mechanism coupled to the capacitance measuring means for
3 controlling a position of the second comb structure.

1 Claim 17. (original) The multi-layer vertical comb-drive actuator of claim 1 further
2 comprising a rotating element mechanically coupled to the second comb structure.

1 Claim 18. (original) The multi-layer vertical comb drive actuator of claim 17, wherein the
2 rotatable element is mechanically coupled to a substrate by a flexure.

1 Claim 19. (original) The multi-layer vertical comb-drive actuator of claim 17 further
2 comprising:

- 3 a) a frame mechanically coupled to the rotatable flexure and hence the rotating
4 element;
- 5 b) a second rotatable flexure disposed along a second axis and mechanically
6 engaged with the frame;
- 7 c) a third comb structure having a one or more third comb fingers; and
- 8 d) a fourth comb structure having one or more fourth comb fingers, wherein
9 the fourth comb structure is positioned such that the fourth comb fingers of
10 the fourth comb structure are interdigitated with the third fingers of the third
11 comb structure;

12 wherein one or more of the third and fourth comb structures have one or more
13 comb fingers including at least one first and at least one second conductive layers,
14 wherein the first and second conductive layers are electrically isolated from each
15 other.

1 Claim 20. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 the first and second conductive layers are electrically isolated by an insulating layer.

1 Claim 21. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 the first and second conductive layers are electrically isolated by an air gap.

- 1 Claim 22. (original) The multi-layer vertical comb drive actuator of claim 19, wherein the
2 first, second, third and fourth comb structures are substantially co-planar.
- 1 Claim 23. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 the axis and the second axis are substantially orthogonal.
- 1 Claim 24. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 the second rotatable flexure is attached to a substrate.
- 1 Claim 25. (original) The actuator of claim 19 wherein the first comb structure is
2 mechanically coupled to the frame and wherein the fourth comb structure is mechanically
3 coupled to the frame.
- 1 Claim 26. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 one or more of the third comb fingers include the first and second conductive layers.
- 1 Claim 27. (original) The multi-layer vertical comb-drive actuator of claim 26, wherein
2 one or more of the fourth comb fingers has at least one first conductive layer aligned with
3 the first conductive layer one or more of the third comb fingers.
- 1 Claim 28. (original) The multi-layer vertical comb-drive actuator of claim 27, wherein an
2 application of a voltage between the second conductive layer of the third comb fingers of
3 and the first conductive layer of fourth comb fingers causes the fourth comb structure to
4 move relative to the third comb structure, thereby causing the rotating element to rotate
5 about the second axis.
- 1 Claim 29. (original) The multi-layer vertical comb-drive actuator of claim 28, wherein
2 one or more of the fourth comb fingers includes a second conductive layer aligned with
3 the second conductive layer of the third comb structure, wherein the first and second
4 conductive layers of the fourth comb fingers are electrically isolated from each other.
- 1 Claim 30. (original) The multi-layer vertical comb-drive actuator of claim 29, wherein
2 the first and second conductive layers of the fourth comb fingers are electrically isolated
3 by an insulating layer.

1 Claim 31. (original) The multi-layer vertical comb-drive actuator of claim 29, wherein
2 the first and second conductive layers of the fourth comb fingers are electrically isolated
3 by an air gap.

1 Claim 32. (original) The multi-layer vertical comb-drive actuator of claim 29, wherein an
2 application of a voltage between the first conductive layers of the third comb fingers and
3 the second conductive layer of the fourth comb fingers causes the fourth comb structure to
4 move relative to the third comb structure, thereby causing the rotating element to rotate
5 about the second axis.

1 Claim 33. (original) The multi-layer vertical comb-drive actuator of claim 19, wherein
2 the fourth comb structure has one or more fourth comb fingers comprising the first and the
3 second conductive layers.

1 Claim 34. (original) The multi-layer vertical comb-drive actuator of claim 33, wherein
2 the third comb structure has one or more first comb fingers comprising at least one first
3 conductive layer in aligned with the first conductive layers of the fourth comb fingers.

1 Claim 35. (original) The multi-layer vertical comb-drive actuator of claim 34, wherein an
2 application of a voltage between the first conductive layers of the third comb fingers and
3 the second conductive layers of the fourth comb fingers causes the fourth comb structure
4 to move relative to the third comb structure, thereby causing the rotating element to rotate
5 about the second axis.

1 Claim 36. (currently amended) The multi-layer vertical comb-drive actuator of claim 19
2 further comprising a means for measuring a capacitance between the third comb fingers
3 [[of the]] and the fourth comb fingers.

1 Claim 37. (original) The multi-layer vertical comb-drive actuator of claim 36 further
2 comprising a feedback mechanism coupled to the capacitance measuring means.

REMARKS:

SPECIFICATION AMENDMENTS

The Applicants have amended the specification at page 22, line 2, to replace “structure” with —substrate—. The Applicants submit that the specification as originally filed clearly identifies element 200 of FIG. 2A as a “substrate” (see, e.g., page 20, line 5). Thus, the amendment merely makes explicit that which was implicit in the specification as originally filed. As such, the Applicants submit that no new matter has been added with this amendment.

CLAIM AMENDMENTS

The Applicants have canceled claims 4, 7, 12 and 14 and amended claims 1, 2, 5, 8-11, 13 and 36 as described below. Claim 1 now recites that both the first and second comb fingers have electrically isolated first and second conductive layers. The Applicants submit that support for this feature can be found in original claim 7, FIG. 1A and corresponding description at page 8, line 11 to page 9, line 2. Claims 2, 5, and 8-11 have been amended to make the claim language and/or claim dependency consistent with amended claim 1. Claim 36 has been amended to correct a minor typographical error.

CLAIM REJECTIONS

35 USC 102

Claims 1-3 were rejected under 35 USC 102(b) as being anticipated by Japanese Patents JP 07-015,981 and JP 05-076,186 to Nakagawa (hereinafter respectively Nakagawa ‘981 and Nakagawa ‘186). The Examiner states that Nakagawa ‘186 teaches an interdigital vertical comb actuator with the second comb having electrically isolated conductive layers separated by an insulating dielectric layer or air gap.

Claims 1-2, 4-6, 12, 14, 17 and 18 were rejected under 35 USC 102(b) as being anticipated by Japanese Patent JP 4-343318 to Nakagawa (hereinafter Nakagawa ‘318). The Examiner states that Nakagawa ‘318 teaches an interdigital vertical comb actuator having electrically isolated conductive layers separated by an insulating dielectric layer with a first comb having first and second conductors substantially aligned with the conductors of the second comb. The Examiner further states that application of a voltage between the combs causes the second comb to rotate on a flexure attached to the substrate.

Claims 1-4, 17 and 18 were rejected under 35 USC 102(b) as being anticipated by U.S. Patent 5,959,760 to Yamada. In rejecting the claims the Examiner states that Yamada teaches an interdigital rotational comb actuator with the first comb having electrically isolated conductive layers separated by an insulating layer and an air gap, where the second comb structure is a rotatable element fixed to the substrate by a flexure.

Claims 1-4, 17 and 18 were rejected under 35 USC 102(b) as being anticipated by Xie et al. "Capacitive Accelerometer with Comb Finger Sensing," (hereinafter Xie). The Examiner states that Xie teaches an interdigital vertical comb sensor with the first combs (stationary) having electrically isolated conductive layers that are separated by an insulating layer. The Examiner further states that Xie teaches a second comb structure having electrodes aligned with the electrodes of the first comb and that the comb structure can be used as an actuator. With respect to claim 13, the Examiner argues that the method of making is not germane to the patentability of the apparatus. The Examiner further argues that Xie teaches springs attached to the z-combs which inherently allow for rotation of the second member.

The Applicants respectfully traverse the rejections. Claim 1 has been amended to recite that both the first and second comb fingers have first and second conductive layers that are electrically isolated. The Examiner has indicated that claim 7, which recites that "the first and second conductive layer of the second comb fingers are electrically isolated from each other," is allowable. Although the Applicants have not included the features of intermediate claims 4 and 5 in claim 1, none of the cited references teaches or suggests first and second comb fingers having first and second conductive layers that are electrically isolated. Instead, each of the cited references specifically shows a set of moving comb fingers with electrically isolated layers but a fixed set of comb fingers having only a single conductive layer. As such, none of the cited references teaches all the limitations of claim 1 as it presently stands in the application. Therefore, claim 1 defines an invention suitable for patent protection.

Furthermore, claims 2, 3, 5, 6, 8-11, 13, and 15-37 depend, either directly or indirectly from claim 1 and recite additional features therefor. As such, the Applicants submit that these dependent claims define an invention suitable for patent protection.

35 USC 103

The Examiner has rejected claims 15 and 16 under 35 USC 103(a) as being unpatentable over Xie in further view of U.S. Pat. No. 6,253,612 to Lemkin (hereinafter Lemkin). Claims 19-28 and 33-35 were similarly rejected as being obvious over Xie in view of Yamada. Finally claims 36 and 37 were rejected as being obvious over Xie in view of Yamada and Lemkin.

The Applicants respectfully traverse the rejection on the grounds that, for the reasons set forth above, Xie does not teach or suggest first and second comb fingers having first and second conductive layers that are electrically isolated as recited in claim. As such, no combination of Xie with Lemkin or Yamada teaches or suggests an apparatus of the type set forth in the rejected claims. As such, a prima facie case of obviousness is not present and claims 15, 16, 19-28 and 33-35 define an invention suitable for patent protection.

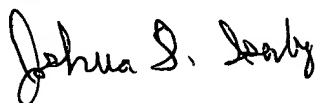
ALLOWABLE SUBJECT MATTER

The Examiner has indicated that claims 7-11 and 29-32 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. However, for the reasons set forth above, the Applicants believe that the claims as they presently stand in the application are allowable over the prior art of record.

CONCLUSION

For the reasons set forth above, the Applicants submit that all claims are allowable over the cited art and define an invention suitable for patent protection. The Applicants therefore respectfully request that the Examiner enter the amendment, reconsider the application, and issue a Notice of Allowance in the next office action.

Respectfully submitted,



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